Five years monitoring of the Lake Muir-Unicup wetland system, south-western Australia

N Gibson[1], G J Keighery[1] & J A K Lane[2]

[1] Science Division, Department of Conservation & Land Management, Wildlife Research Centre, PO Box 51 Wanneroo, Western Australia 6065
[2] Science Division, Department of Conservation & Land Management, 14 Queen Street Busselton, Western Australia 6280
✉ neilg@calm.wa.gov.au

(Manuscript received July 2003; accepted June 2004)

Abstract

The vegetation of 27 wetlands was monitored over a five year period (1997 to 2002) in the Lake Muir-Unicup system east of Manjimup, where salinization has been reported over the last decade. Initial results suggest that only three wetlands have deteriorated over this period. However given the lag times known to occur in groundwater movements and the appearance of new saline seeps in the catchment, it is unlikely that the ground water system is yet in equilibrium. There is an urgent need for ground water management programs to be developed to protect biodiversity values. Detailed hydrological mapping of the catchment is currently underway.

Keywords: Monitoring, wetlands, salinity, Muir-Unicup catchment

Introduction

Dryland salinity is one of the most serious concerns for conservation management in the South West Botanical Province (George *et al.* 1995) which has been recognized as one of the world's 25 biodiversity hotspots under threat (Myres *et al.* 2000). The salinity problem has arisen as a result of the large scale clearance of perennial native vegetation for annual cereal crop and pasture production with the subsequent rise in water tables and mobilization of salt that was previously confined deep in the soil profiles. Because of their position low in the landscape, wetlands are generally considered one of the first habitats to be impacted by rising saline ground water. The problems in wetlands are often exacerbated by drainage works.

In 1996 the Western Australian Government released a Salinity Action Plan to address a number of issues arising from salinity (Government of Western Australia 1996). One of the strategies was to designate recovery catchments which would be allocated resources to protect biodiversity values. The Lake Muir-Unicup system of wetlands was one of the first identified, on the basis of outstanding fauna and flora values (Australian Nature Conservation Agency 1996; Gibson & Keighery 2000). Based on these same data the Muir-Byenup system, south of the Muir Highway, was subsequently nominated (Government of Western Australia 2000) and listed (Wetlands International 2002) as a Ramsar wetland of international importance.

In 1997 a series of 41 permanent plots was established in 27 wetlands to monitor vegetation change through time and to provide a mechanism to assess the effectiveness of conservation management activities carried out in the Lake Muir-Unicup catchment. This catchment is situated in the 600 – 800 mm rainfall zone and wide-scale plantings of eucalypt plantations for fiber production was believed to provide an economically feasible way to control rising water tables. This paper reports on the changes in wetland vegetation for the five years commencing in 1997.

Methods

Vegetation cover was recorded in 41 quadrats located in 27 wetlands in October 1997. Most were resurveyed in October 2002, however five quadrats (from three wetlands) could not be accessed at that time and were instead resurveyed in March 2003 (Fig. 1). Each quadrat was 5 m x 10 m with corners marked by steel star bars or droppers. Lists were compiled of all vascular species recorded in each quadrat and a percentage cover class was visually estimated for each species (<2, 2–10, 10–30, 30–70, >70%). In basin wetlands plots were laid out with their long axis parallel to the shoreline. Between one and three plots were established in different vegetation zones at each wetland. Where multiple quadrats were used, quadrats were placed in parallel along the littoral gradient. In all, five broad wetland types were sampled (*Baumea articulata* basin wetlands; flats and riparian zones dominated by *Baumea juncea;* swamps and flats with understorey dominated by *Lepidosperma longitudinale;* other wet flats; and one seasonally inundated claypan). The position of each quadrat was fixed with a GPS unit.

To test whether a significant change in vegetation cover of the quadrats had occurred over the five years a similarity matrix using midpoint cover values was constructed using Bray-Curtis similarity coefficients with data from all quadrats at both sampling times. This matrix was analyzed using the non parametric ANOSIM routine (Primer v5.2.8 Clark & Gorley 2001) which tests for differences between rank similarities of quadrats between years using a permutation test.

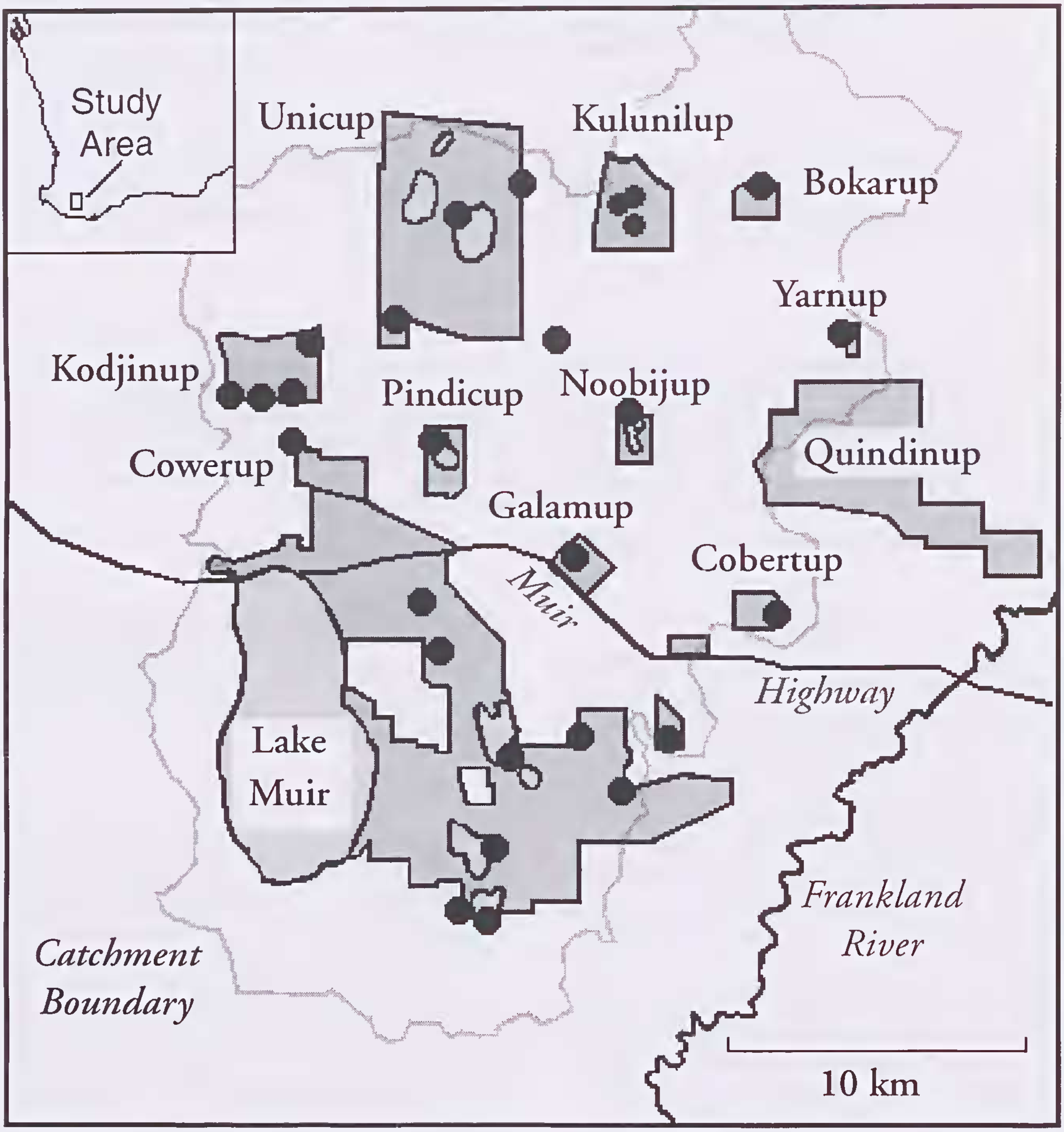

Figure 1. Location of the 27 wetlands (black dots) containing the 41 monitoring quadrats in the Lake Muir-Unicup catchment (light grey line). Nature Reserves occurring in the catchment are also shown.

Differences were further examined using two dimensional non-metric multidimensional scaling ordination (MDS in Primer v5.2.8) of the complete dataset and computing the distance quadrats moved in ordination space over the five year period.

At several of the wetlands in the Lake Muir-Unicup catchment, regular measurements are taken of water depth and water chemistry as part of the Department of Conservation and Land Management's long term wetland monitoring project begun in 1978 (Lane & Munro 1981).

Results

The five broad wetland types sampled were closely correlated with geomorphological position and floristic composition (N Gibson, unpublished data). Of these the *Baumea articulata* basin wetlands were very species poor and the flats and riparian zones dominated by *Baumea juncea* were less floristically variable than other wetland types (Fig. 2a).

The sample statistic from the ANOSIM analysis was -0.02 which was not significant (P = 0.97) indicating that

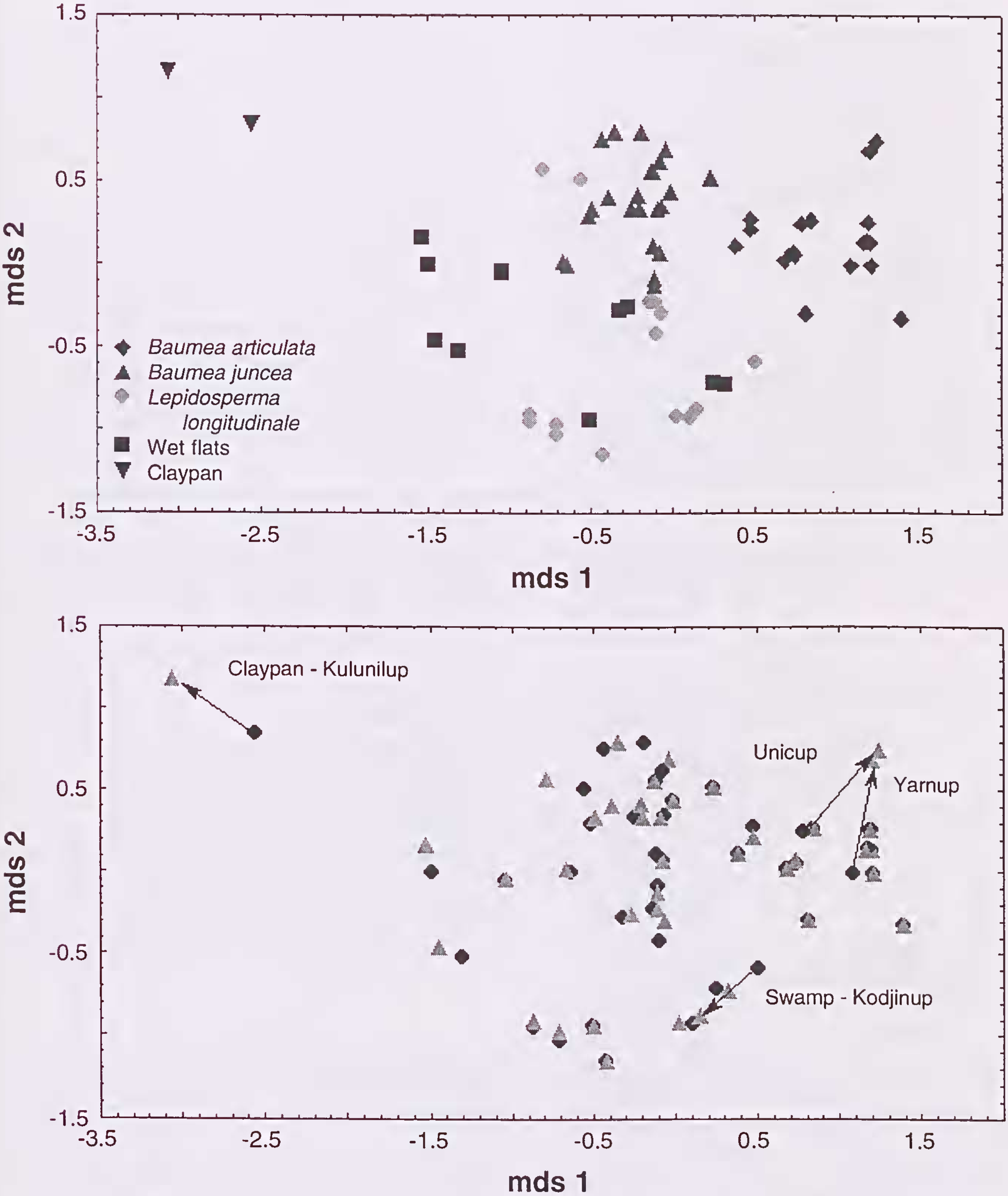

Figure 2. (a) Ordination showing five broad wetland types: *Baumea articulata* basin wetlands, flats and riparian zones dominated by *Baumea juncea*, swamps and flats with understorey dominated by *Lepidosperma longitudinale*, other wet flats, and claypans. (b) Non-metric multidimensional scaling ordination of the 41 quadrats in 1997 (diamonds) and 2002 (triangles) based on cover abundance data. The four quadrats that showed large movement in ordination space are indicated by an arrow.

there was no significant change in species abundance as a whole in the 41 quadrats over the five year period. A plot of the two dimensional ordination coded by year shows little or no movement for most quadrats in ordination space consistent with the ANOSIM results.

When the change in distance in ordination space for individual quadrats was calculated four quadrats showed large movement (Fig. 2b). Two of these quadrats were from species-poor *Baumea articulata* basin wetlands, the third from a *Melaleuca* swamp and

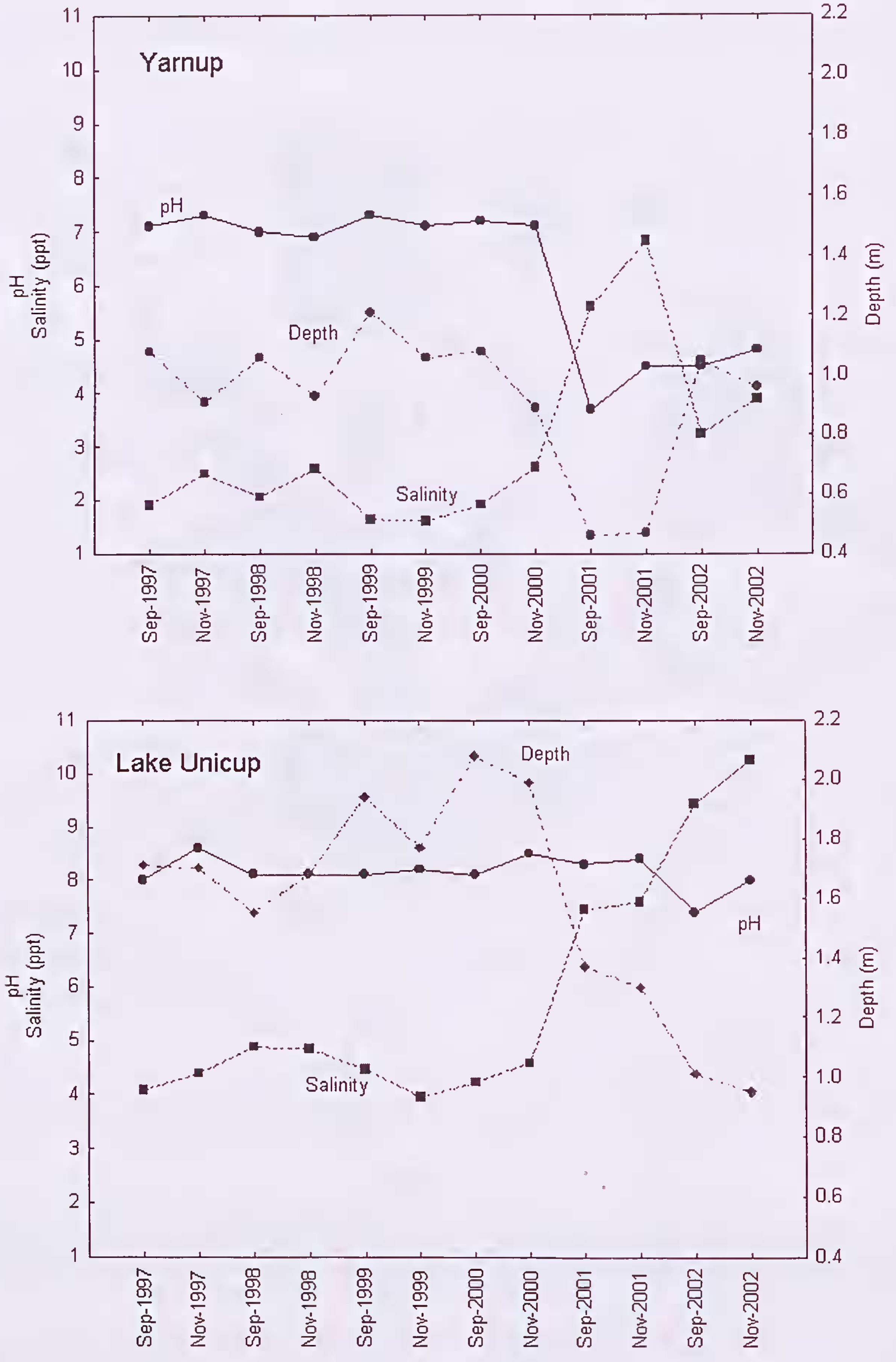

Figure 3. Changes in water pH, salinity and depth over the period 1997 to 2002. Water chemistry and depth were recorded twice yearly in September and November. (a) Yarnup; (b) Lake Unicup.

the fourth from a seasonally inundated claypan.

The two quadrats from species-poor *Baumea articulata* wetlands (Yarnup and Unicup) had a major collapse of the dominant species (the cover abundance scores of *B. articulata* changed from 30–70% to 2–10%). The Yarnup quadrat was immediately adjacent to the depth gauge while the Unicup quadrat was 100 m to the north of the depth gauge.

Water depth and pH of Yarnup Swamp were markedly lower in 2001 than in previous years and pH remained low in 2002 even after the return to more normal water depths (Fig. 3a). Similarly Yarnup's salinity was markedly higher in 2001 than in previous years and was also higher than usual in 2002 despite an increase in water depth. This wetland has a long term (1980–2002) trend of increasing salinity (JAK Lane, unpublished data). There was a marked decline in water depth – and increase in salinity – of Lake Unicup in 2001 and 2002 (Fig. 3b), however lake water pH did not change significantly.

The third site to show marked change over the monitoring period was a *Melaleuca* swamp in Kodjinup Nature Reserve. Here in 1997 the understorey was dominated by *Lepidosperma longitudinale* (30–70% cover) and *Baumea articulata* (10–30% cover) but by 2002 the *B. articulata* had almost disappeared. Only this single species showed a change in abundance at this quadrat. It is unclear whether this change represents gradual compositional shift of the swamp or an abrupt change of state since no water depth or water chemistry data are available.

The final quadrat that showed large movement in the ordination scores between 1997 and 2002 was on a seasonally inundated claypan in Kulunilup Nature Reserve. This claypan was dominated by *Apodasmia ceramophila* and these flats are characterized by the recruitment of a series of annual taxa as the claypan dries (N Gibson, unpublished data). The change noted at this quadrat is likely to have resulted from the claypan being sampled at different drying and floristic stages in October 2002 compared with October 1997. It does not represent habitat deterioration.

Discussion

The results of this monitoring are initially encouraging in relation to the maintenance of the biodiversity values of the wetlands in the Lake Muir-Unicup catchment. Only four of the 27 wetlands sampled showed obvious change over the study period. Two of these wetlands are known to have undergone significant changes in water quantity and / or quality during the period of monitoring. However, the lag period between land clearance and impact, and between restoration of perennial cover and improvement in ground water quality and depth, are known to be significant, perhaps being in the order of decades (National Land and Water Resources Audit 2001). Hence, results from any single monitoring interval need to be interpreted carefully.

More worrying in relation to the Lake Muir-Unicup catchment was the appearance of new saline springs both high and low in the landscape over the period 1997 – 2002 which were not related to surface drainage nor known hydrological source areas (R. Hearn, 2002, CALM, personal communication). These springs have appeared in upland areas in Unicup Nature Reserve, and in low lying areas of Kulunilup and Bokarup Nature Reserves but are not associated with the basin wetlands of these reserves.

The appearance of these springs suggests that current ground water levels are not yet in equilibrium and that the hydrological system is complex given that saline influences are not initially seen in basin wetlands where ground water intersection may have been first expected.

Detailed hydrological investigations are presently underway to identify recharge and discharge areas which will allow effective ground water management strategies to be developed (R. Hearn, 2003, CALM, personal communication). The three affected wetlands urgently need ground water management programs.

Acknowledgements: Bill Muir, Grant Pearson and Kate Brown assisted in the fieldwork, CALM regional staff, particularly Roger Hearn and Ian Wilson, assisted with the logistics and material for the project.

References

Australian Nature Conservation Agency (1996). A Directory of Important Wetlands in Australia, Second Edition. Australian Nature Conservation Agency, Canberra.

Clarke, KR & Gorley, RN (2001) PRIMER v5: User Manual / Tutorial. PRIMER-E, Plymouth.

George, RJ, McFarlane, DJ & Speed, RJ (1995) The consequences of a changing hydrologic environment for native vegetation in Western Australia. In: The Role of Networks. (DA Saunders, JL Craig & EM Mattiske eds) Surrey Beatty & Sons, Chippington Norton, 9–22.

Government of Western Australia (1996) Western Australian Salinity Action Plan. Government of Western Australia, Perth.

Government of Western Australia (2000) Wetlands nominated by the Government of Western Australia for inclusion on the List of Wetlands of International Importance, Ramsar Convention. Nominating document prepared by WA Department of Conservation and Land Management, Perth. 48pp.

Gibson, N & Keighery, GJ (2000) Flora and vegetation of the Byenup – Muir reserve system, south-west Western Australia. CALMScience 3: 323–402.

Lane, JAK & Munro, DR (1981) 1980 review of rainfall and wetlands in the south-west of Western Australia. Department of Fisheries and Wildlife, Western Australia, Report 47:1–23.

Myres, N, Mittermeler, RA, Mittermeler, CG, da Fonseca, GAB, & Kent, J (2000) Biodiversity hotspots for conservation priorities. Nature 403: 853–858.

National Land and Water Resources Audit (2001) Australian Dryland Salinity Assessment. Extent, impacts, processes, monitoring and management options. National Land and Water Resources Audit, Canberra.

Wetlands International (2002) Ramsar Sites: Directory and Overview, a guide to the Ramsar Convention's Wetlands of International Importance, Global Series 13, WI, Wageningen, The Netherlands.